Preliminary comparisons of AIRS V6.6.5 with ozonesondes and PREPQC sondes
and
Updates on single-footprint retrievals from AIRS

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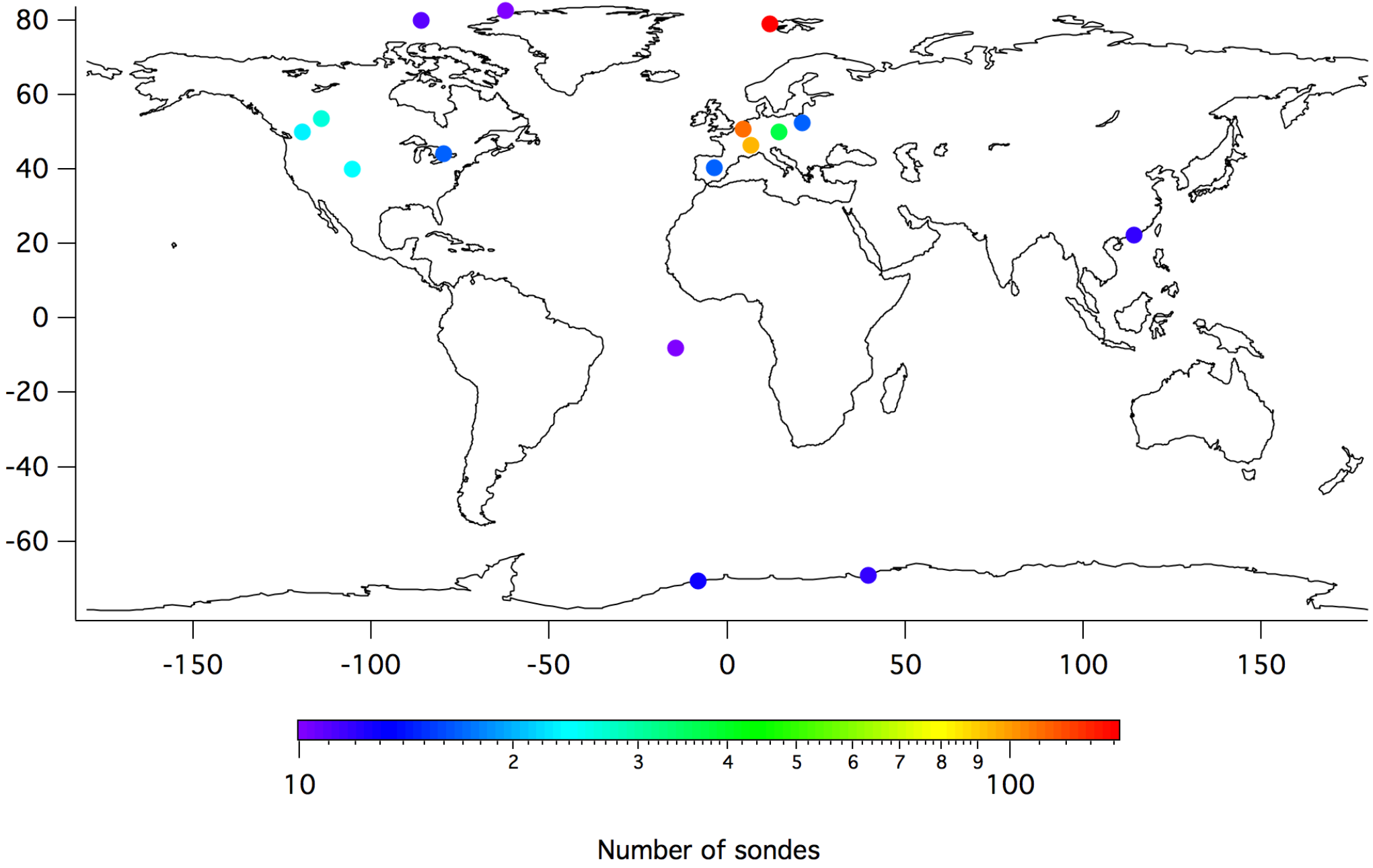
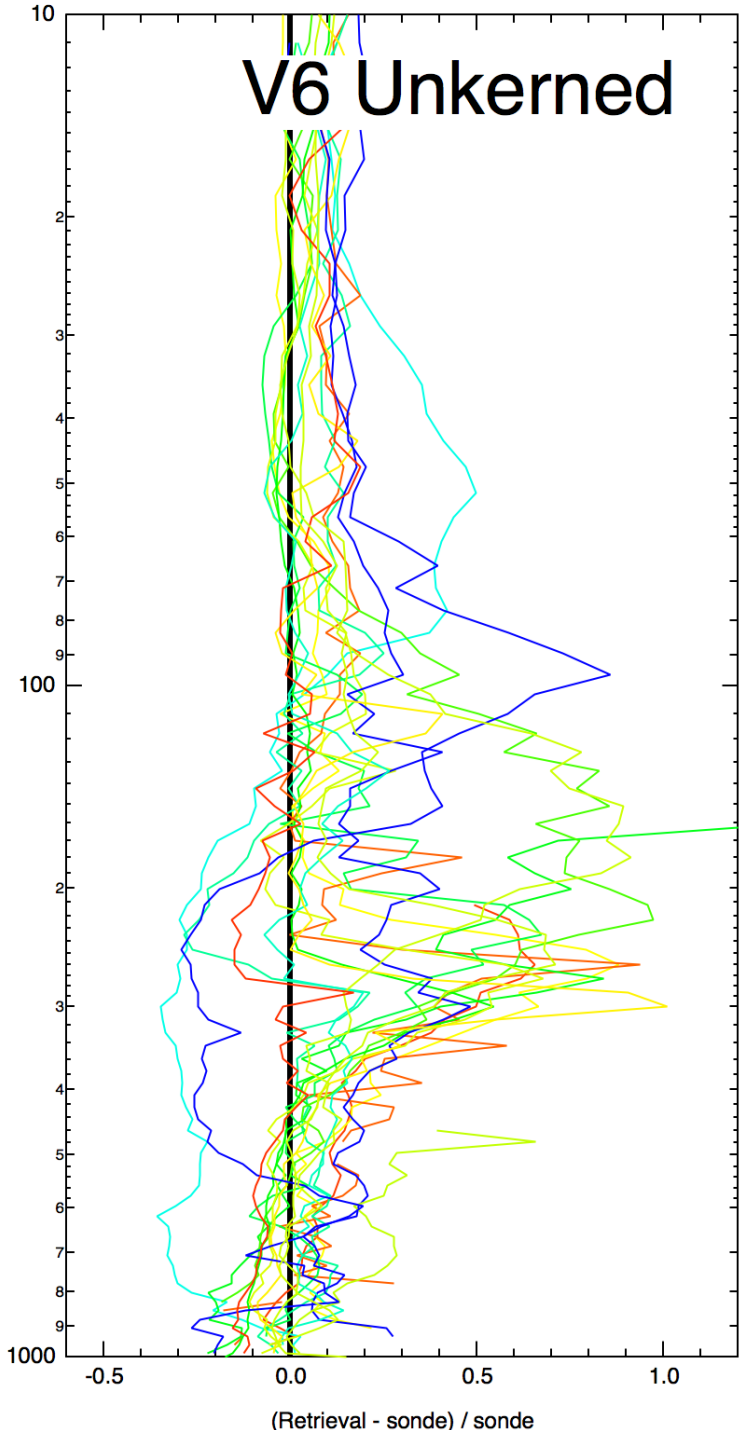
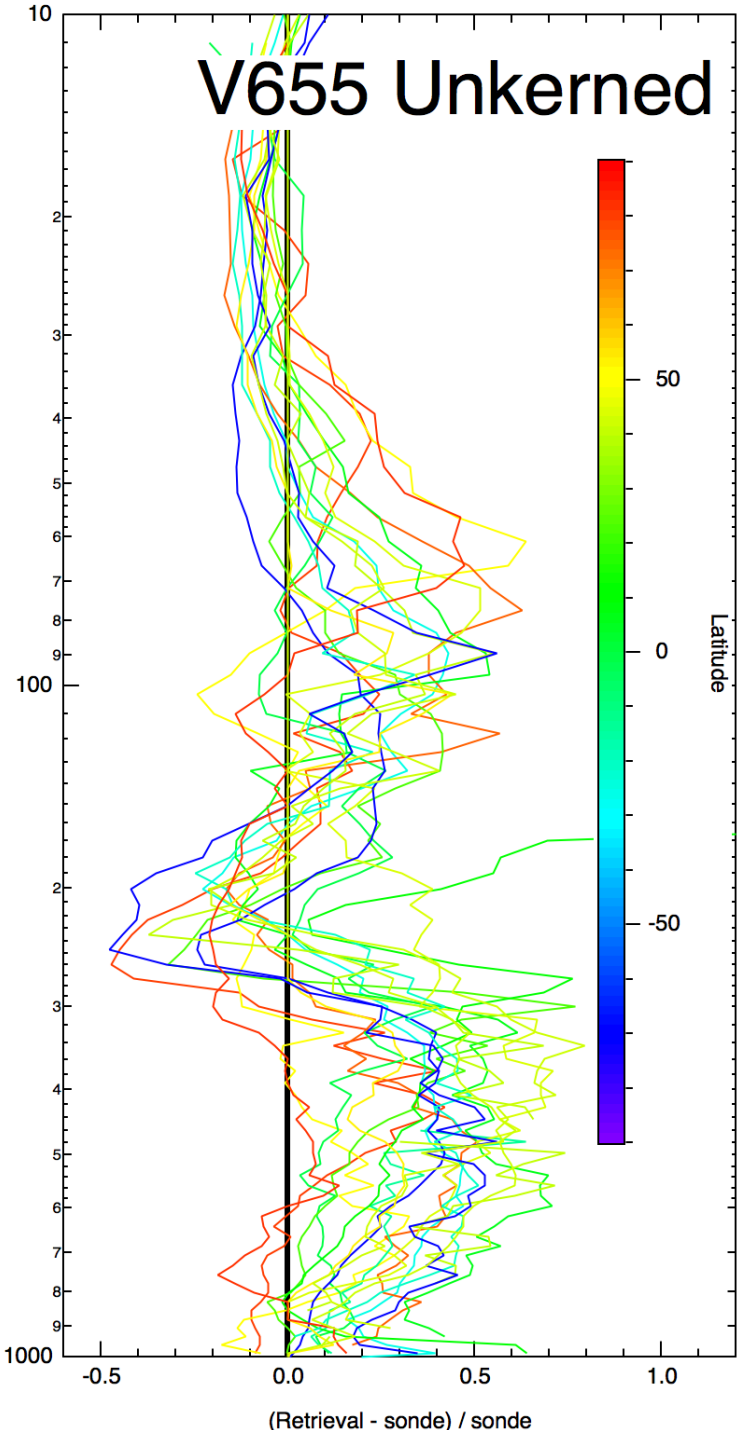
With thanks to my colleagues, in particular Evan Manning

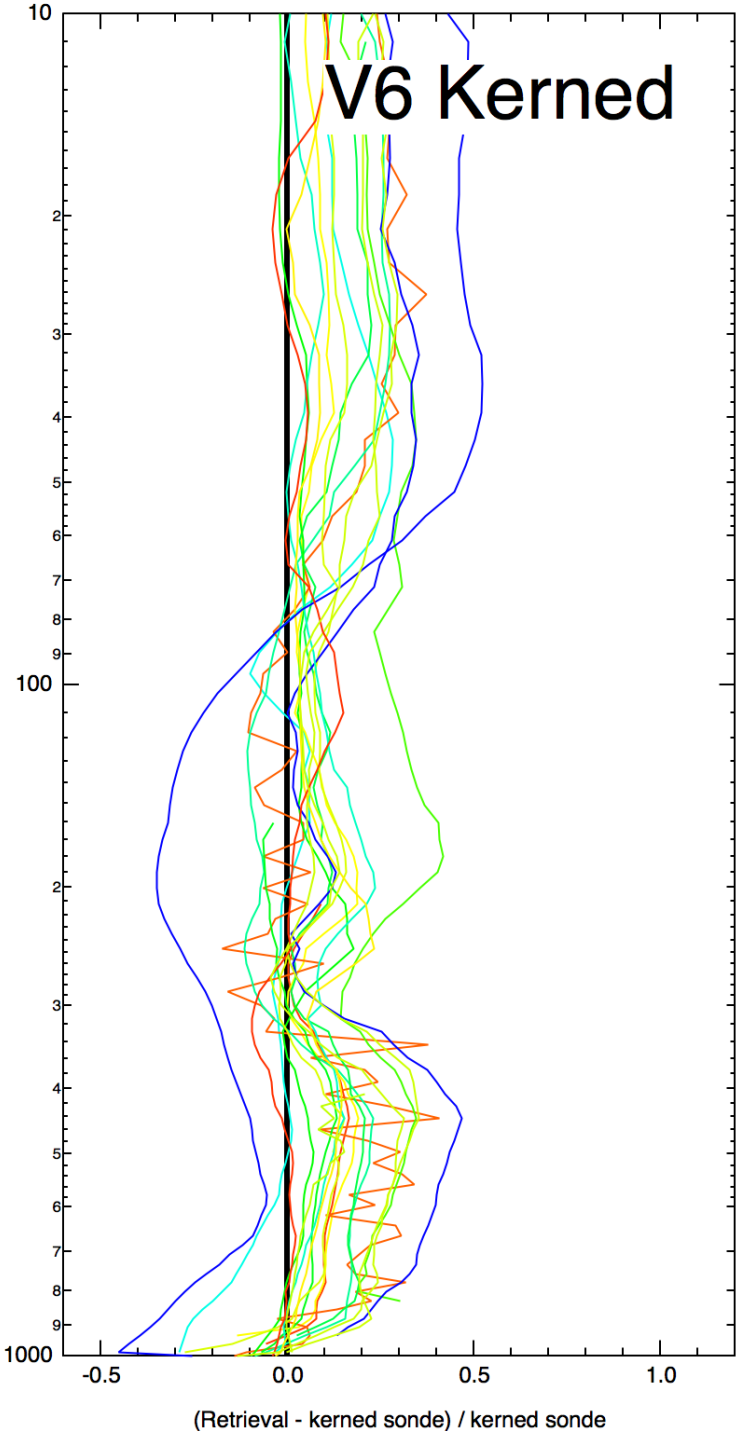
Preliminary V6.5.5 ozone vs V6

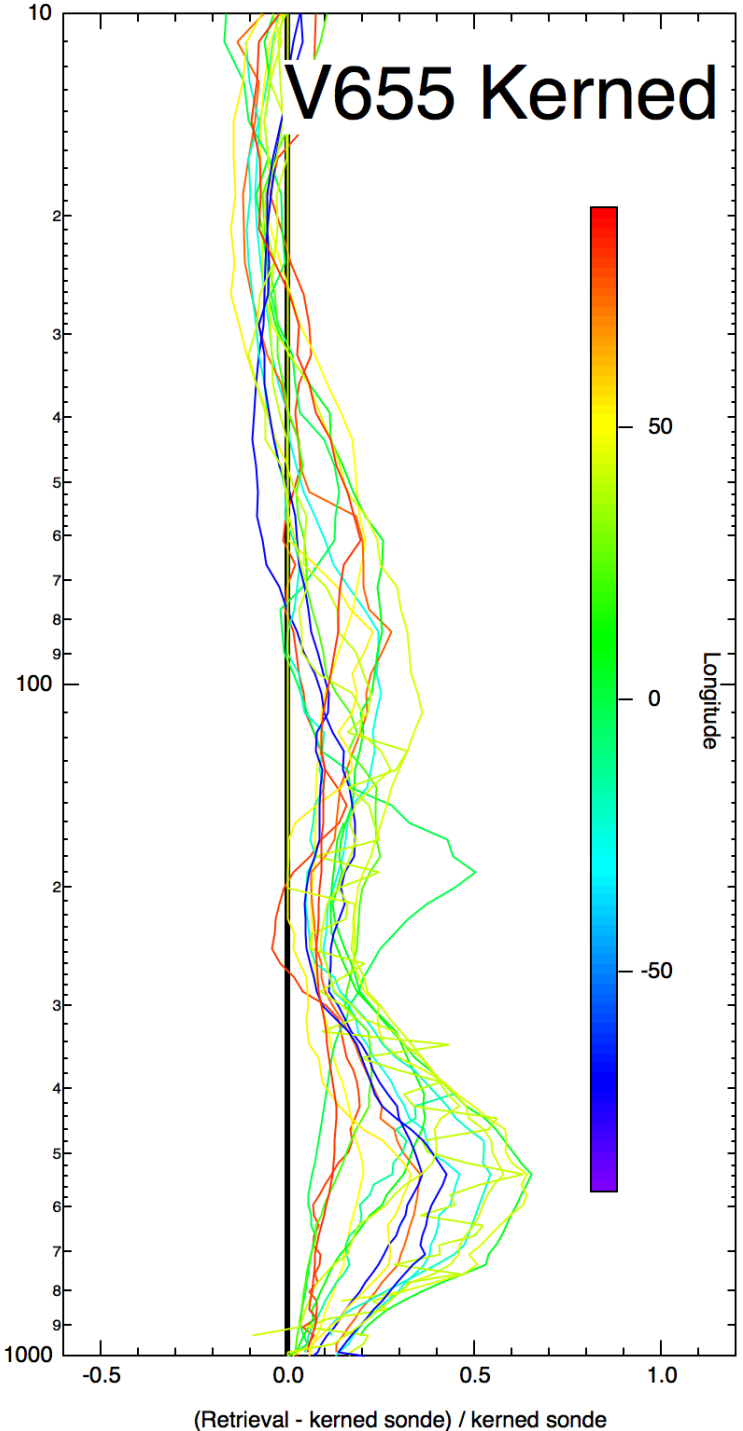
- Gather AIRS V6.5.5 matchups within 3 hrs and 100 km of sonde launch
  - 791 sondes (so far)
- For both V6 (w/MW) and V6.5.5, calculate profile biases against L2 support retrievals using “raw” and “kerned” sonde data
  - $\mathbf{x}_{kerned} = \mathbf{x}_0 + \mathbf{A}(\mathbf{x}_{true}-\mathbf{x}_0)$
    - what AIRS “should have seen”
    - 9 trapezoids in V6, 20 trapezoids in V6.5.5
    - V6 $\mathbf{x}_0$ from climatology, V6.5.5 $\mathbf{x}_0$ in L2 support
- Calculate median bias for each sonde ([AIRS – sonde] / sonde)
  - 5 AIRS observations minimum
- Calculate median bias for each site
  - 10 sonde launches minimum with at least 5 AIRS observations
  - 17 sites had enough data for these last two criteria


80
60
40
20
0
-20
-40
-60
-150
-100
-50
0
50
100
150
10
2
3
4
5
6
7
8
9
100
Number of sondes


V6 Unkerned
10
2
3
4
5
6
7
8
9
100
2
3
4
5
6
7
8
9
1000
-0.5
0.0
0.5
1.0
(Retrieval - sonde) / sonde


V655 Unkerned
10
2
3
4
5
6
7
8
9
100
2
3
4
5
6
7
8
9
1000
-0.5
0.0
0.5
1.0
(Retrieval - sonde) / sonde
50
0
-50
Latitude


V6 Kerned
10
2
3
4
5
6
7
8
9
100
2
3
4
5
6
7
8
9
1000
-0.5
0.0
0.5
1.0
(Retrieval - kerned sonde) / kerned sonde


V655 Kerned
10
2
3
4
5
6
7
8
9
100
2
3
4
5
6
7
8
9
1000
-0.5
0.0
0.5
1.0
(Retrieval - kerned sonde) / kerned sonde
50
0
-50
Longitude

Preliminary V6.5.5 temperature trend vs V6

- Select better quality sondes from PREPQC files
  - Per Kevin Yau's recipe on PREPQC quality flags
- Find AIRS matchup profiles
  - For now, **only for January 2004 – 2016**
  - 3 hr, 100 km maximum miss time/distance from sonde launch
- Interpolate radiosonde temperature to AIRS gridding
- Use AIRS first guess and averaging kernel on radiosonde to create "kerned" radiosonde profile:

$$x_T^* = x_0 + A(x_T - x_0)$$

Temperature bias trend (January ONLY)

60N – 90N

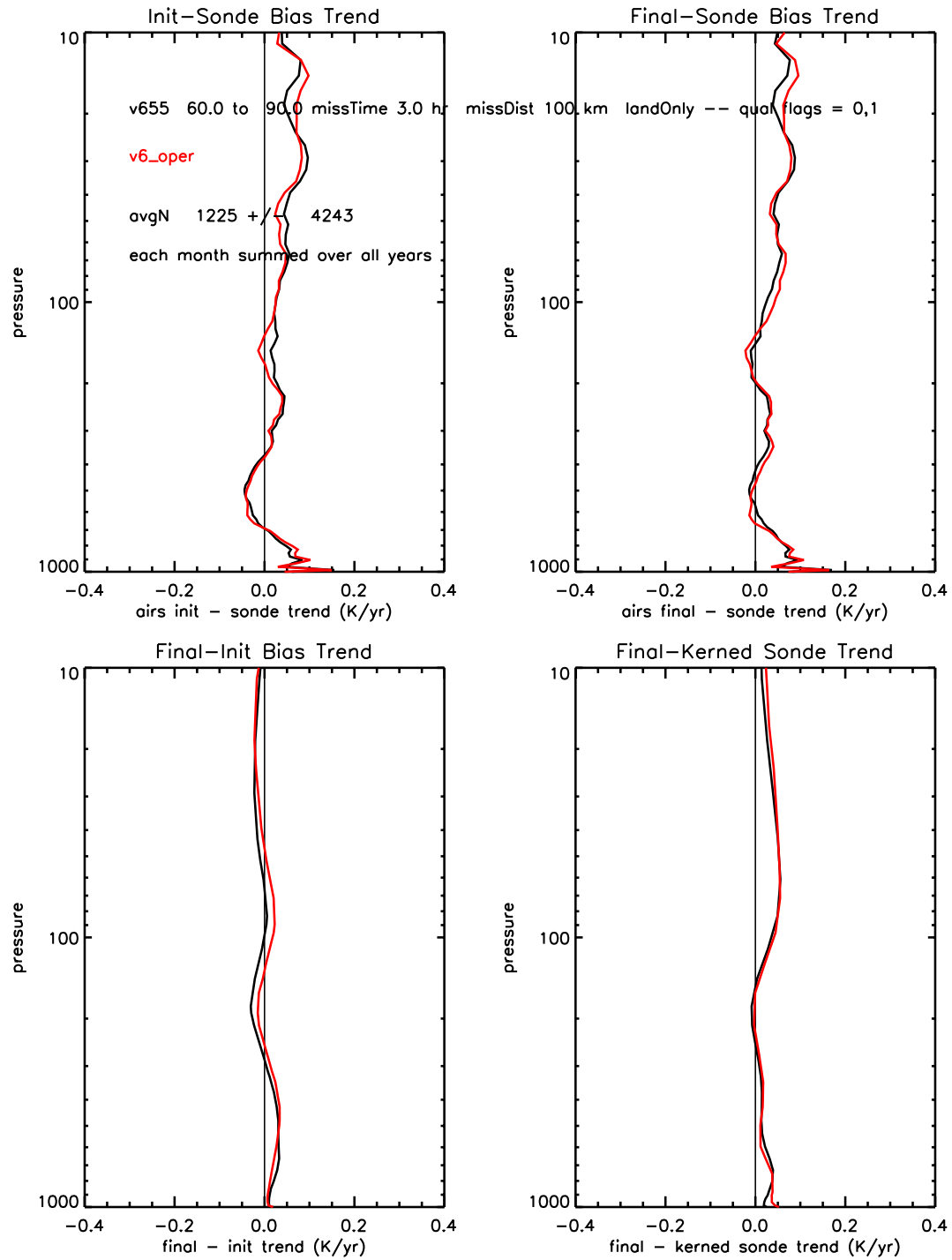
Black lines – V655
Red lines – V6

Temperature qual flags = 0,1
Land only

±3 hr maximum miss time from sonde launch

100 km maximum miss distance

(avgN = avg obs for a month totalled from 1/04 to 1/16).



Temperature bias trend (January ONLY)

30N – 60N

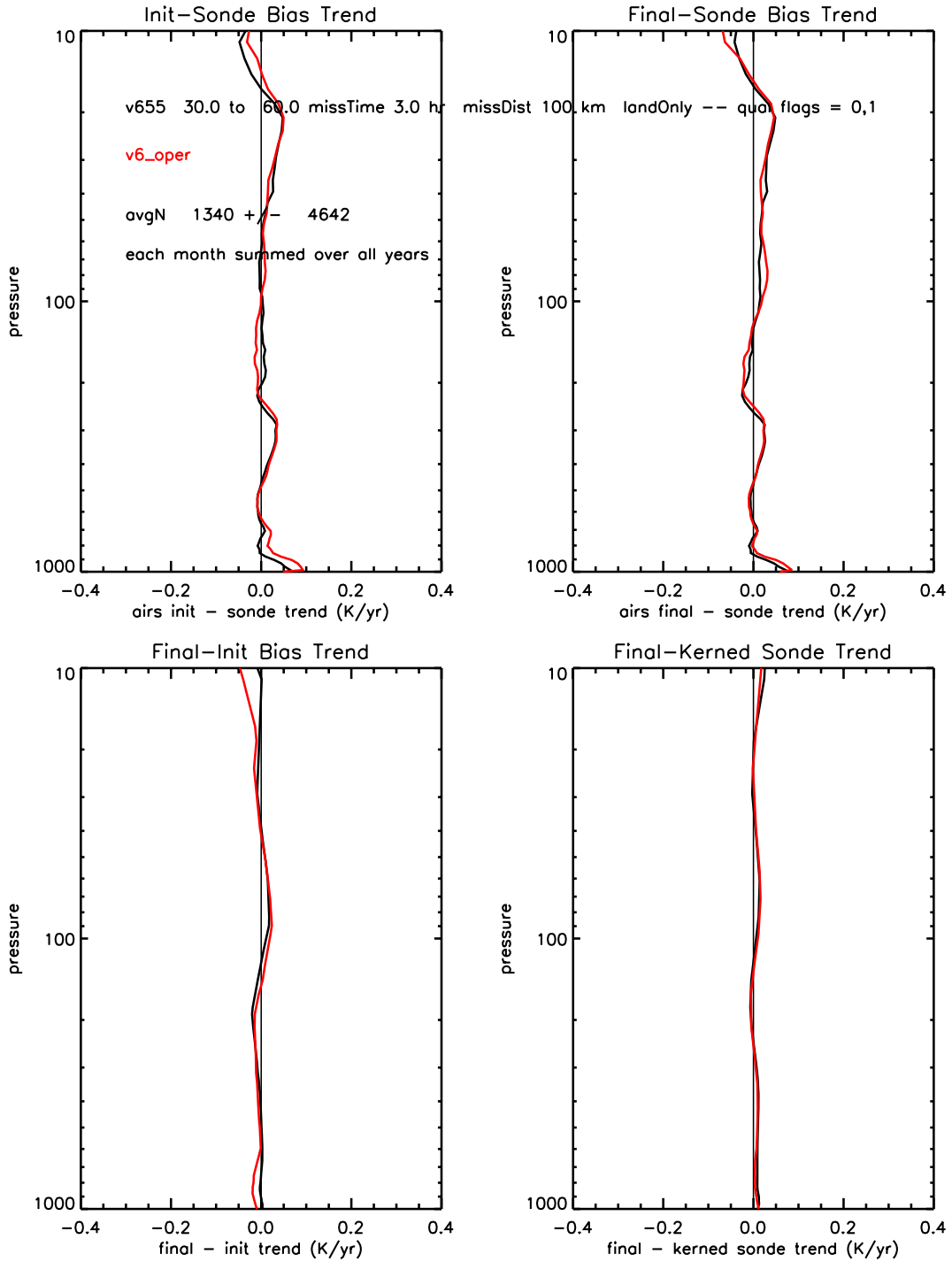
Black lines – V655
Red lines – V6

Temperature qual flags = 0,1
Land only

±3 hr maximum miss time from sonde launch

100 km maximum miss distance

(avgN = avg obs for a month totalled from 1/04 to 1/16).



Temperature bias trend (January ONLY)

15N – 30N

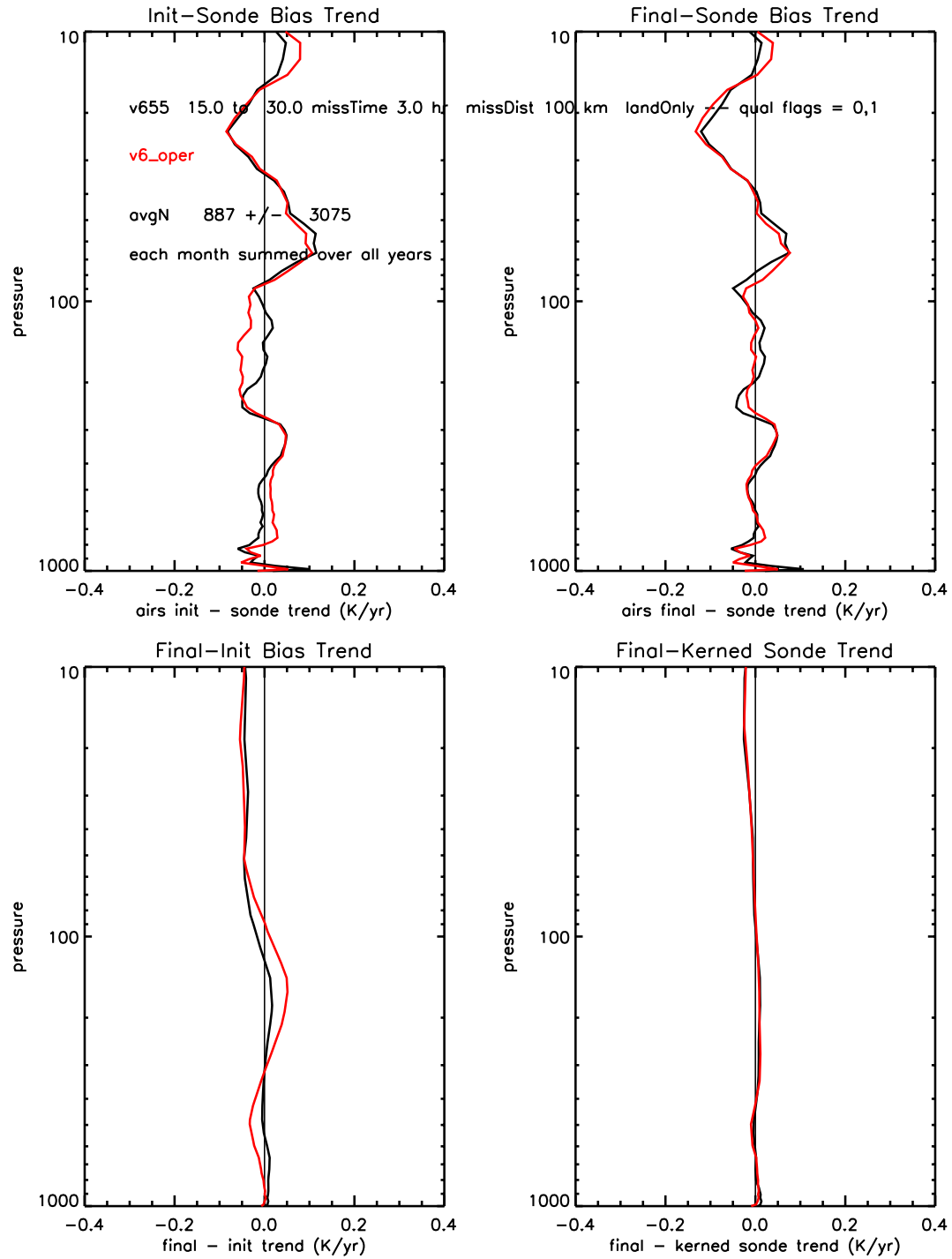
Black lines – V655
Red lines – V6

Temperature qual flags = 0,1
Land only

±3 hr maximum miss time from sonde launch

100 km maximum miss distance

(avgN = avg obs for a month totalled from 1/04 to 1/16).



Temperature bias trend (January ONLY)

90S – 60S

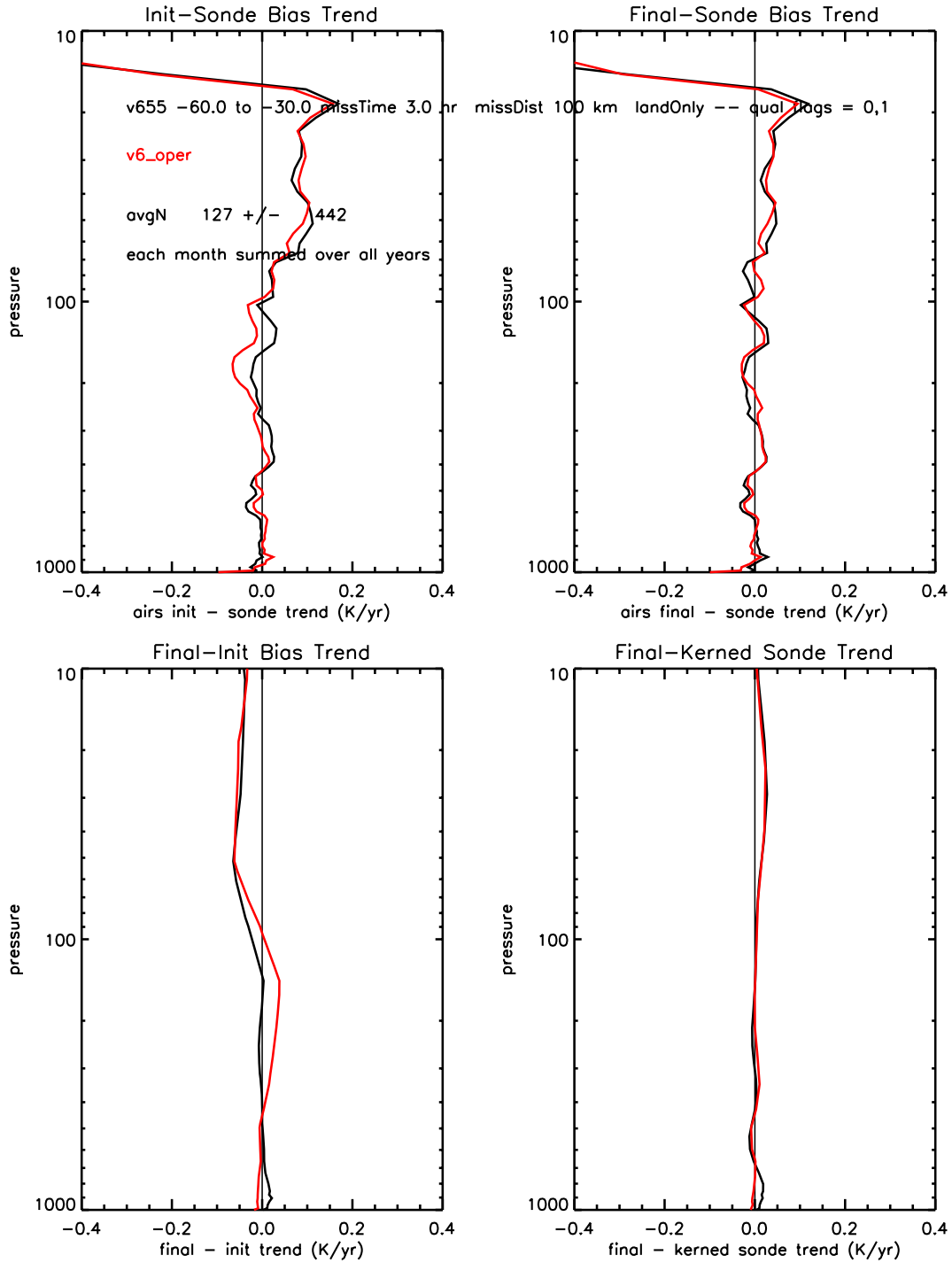
Black lines – V655
Red lines – V6

Temperature qual flags = 0,1
Land only

±3 hr maximum miss time from sonde launch

100 km maximum miss distance

(avgN = avg obs for a month totalled from 1/04 to 1/16).



Speeding-up the single-footprint retrieval

Modify F90 version of SARTA to save predictors if they don't need re-calculation (useful for Jacobian calculations)

Use pre-processor to average MODIS cloud data over AIRS spatial response, and ECMWF *a priori*

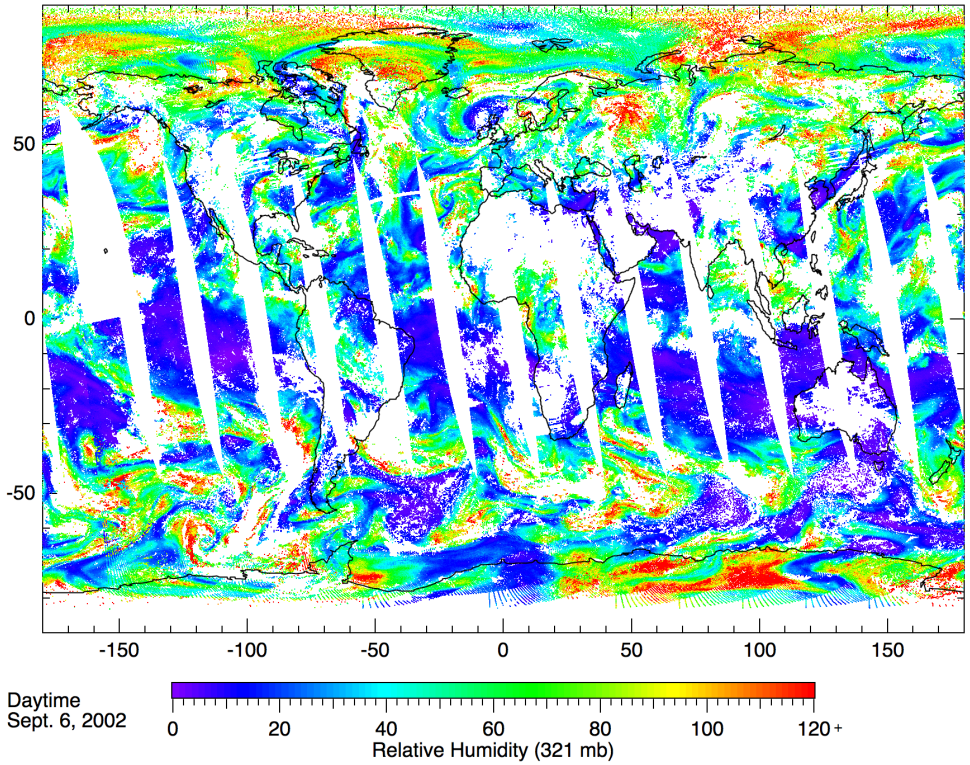
- Working with Mathias on methods to speed-up MODIS pre-processing

Simple spatial interpolation of U. Wisconsin emissivity rather than weighted average over AIRS spatial response

Use method of DiNatale et al. (2017) (following Broyden, 1965) to estimate Jacobians when χ^2 is decreasing:

$$\mathbf{K}_{i+1} = \mathbf{K}_i + \frac{[(\mathbf{F}(x_{i+1}) - \mathbf{F}(x_i) - \mathbf{K}_i \Delta x_i)\Delta x_i]}{(\Delta x_i^T \cdot \Delta x_i)} \; ; \; \Delta x_i = x_{i+1} - x_i$$

Nighttime *a priori* cloud optical depth varies with MODIS cloudiness flag



Lowers time required for single retrieval from ~15 s to ~5.5 s

(or from ~50 hrs per 135x90 granule to ~18.5 hrs on a single processor).

Questions?